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CATARACT CREEK DAM

Manual for Operation and Maintenance

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**Initial Publication May 1995
Revised May 2001**

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OVERVIEW

Cataract Creek Dam is located in Madison County, about 2 miles southwest (upstream) from the community of Pony and 8 miles southwest of the Town of Harrison (see Figure 1). The reservoir is fed by Cataract Creek, which originates 2.3 miles southwest of Cataract Creek Dam at Mason Lake (see Figure 2). Figure 3 provides a general layout of the dam, spillway and outlet works.

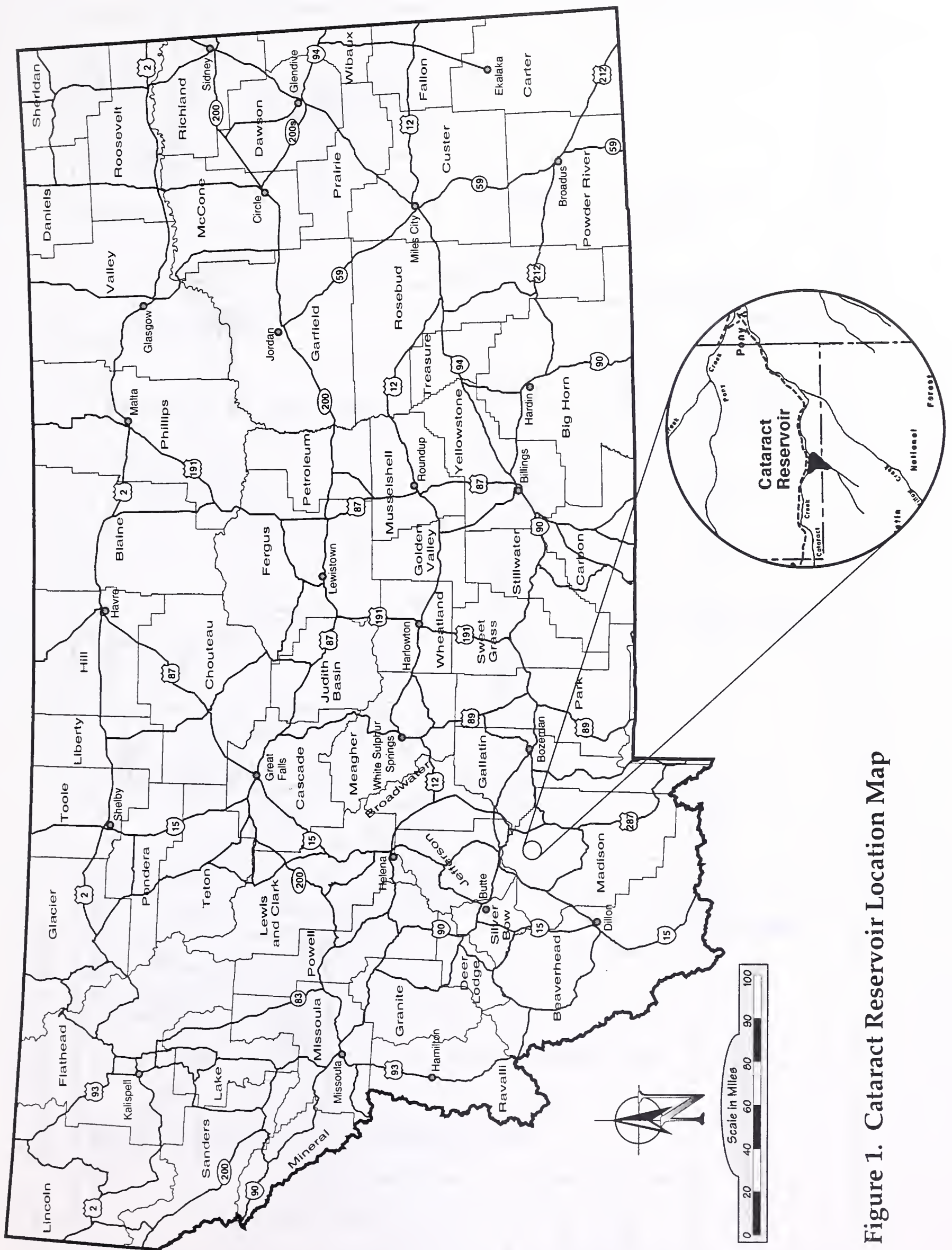
The dam is owned by the Montana Department of Natural Resources and Conservation (DNRC) and is managed by the State Water Projects Bureau (SWPB) of the DNRC. The Cataract Water Users Association (herein called the “association”) operates and maintains the dam.

The earthfill dam was completed in 1959. Cataract Creek Dam is 80 feet high and 775 feet long. The dam's outlet works consist of a square dry tower (5.5 by 5.3 feet) with two 30-inch diameter gate valves. The upstream valve is used for emergency shutoff, while the downstream valve is the operating valve. The operating valve is operated by a handle located at the top of the tower. The emergency valve is operated by a hand wheel located at the bottom of the tower. The maximum capacity of the outlet works is 160 cubic feet per second (cfs).

The spillway is located in the right abutment and consists of earthen channel, a concrete drop structure and an earthen exit channel to Cataract Creek. The spillway drop structure has a bottom width of 20 feet, side slopes of 1v to 1.5h and are 5 feet high, sides and bottom are 6 inches thick, and a jointed 6 inch diameter concrete drain pipe is on each side of the 20 feet wide

bottom. When the spillway spills, the water has eroded a large cut where the channel drops into Cataract Creek. The maximum capacity of the spillway is 1,250 cfs.

The reservoir has a normal capacity of 1,478 acre-feet at the spillway crest and a maximum capacity at the dam crest of 1,800 acre-feet. Water from the reservoir is delivered to association members via Cataract Creek and North Willow Creek to their diversions on North Willow Creek. Water from the reservoir is primarily used for irrigation water supply. The reservoir is also used for water-based recreation.



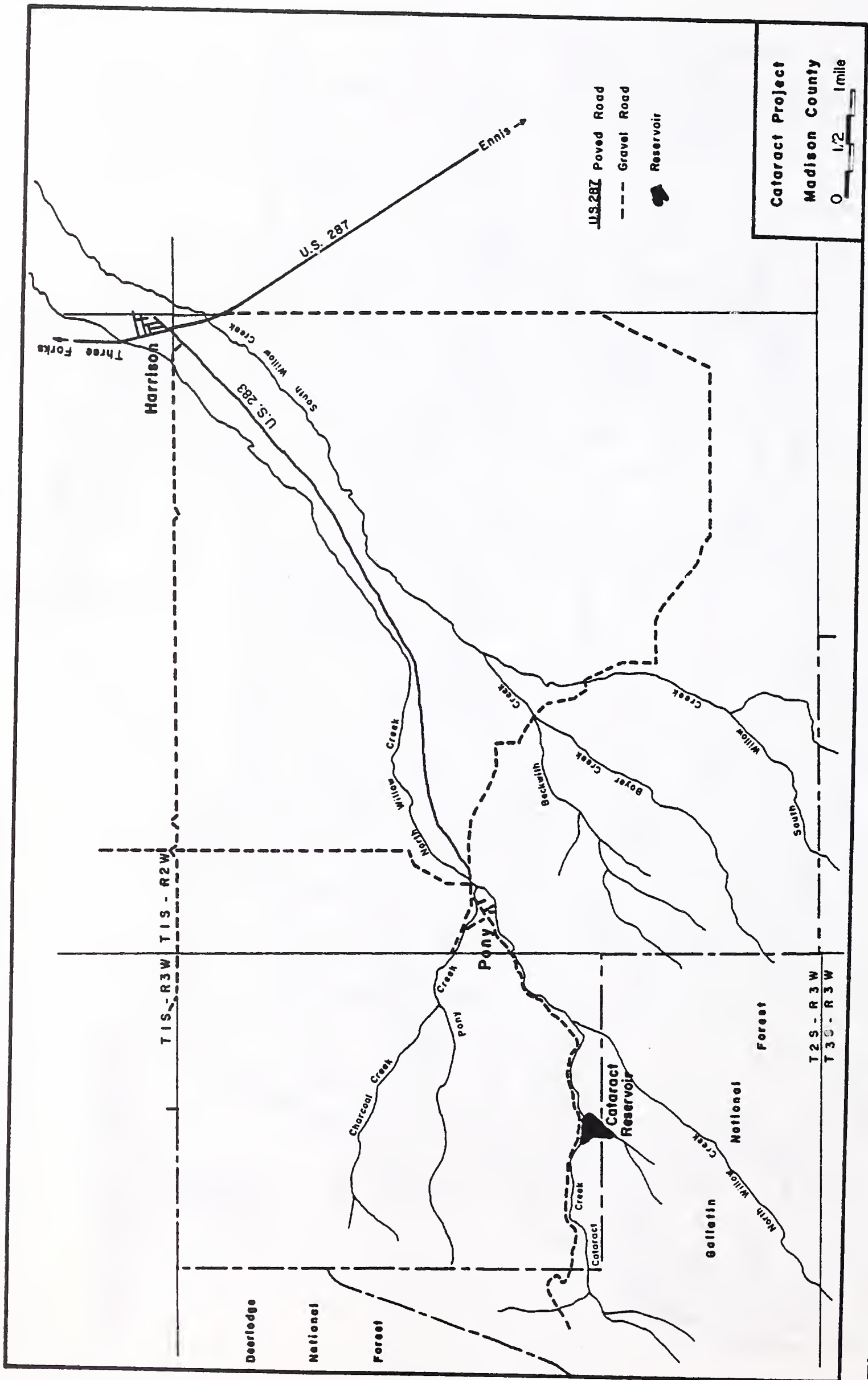


Figure 2. Cataract Project Map

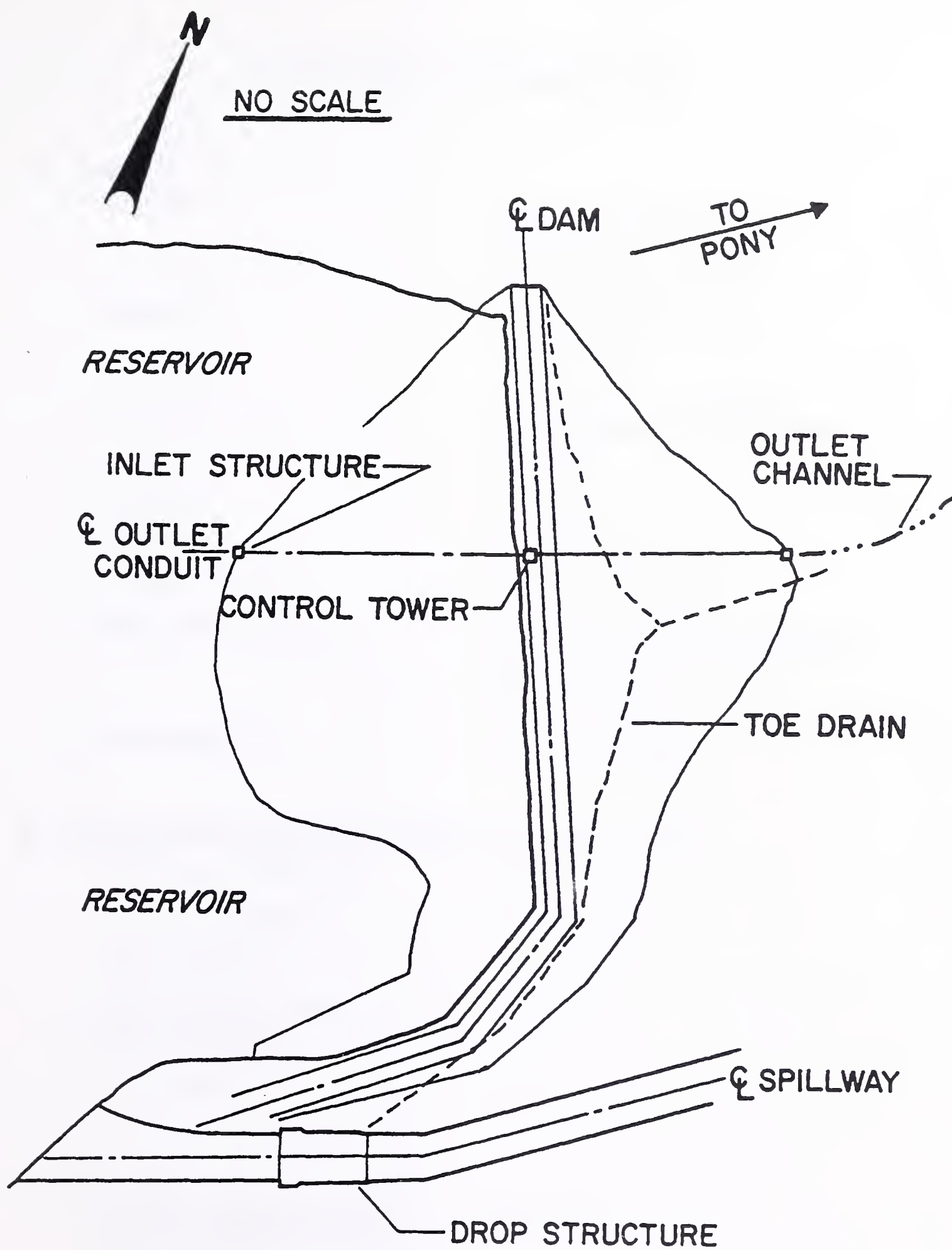


Figure 3. Cataract Dam General Layout

STATISTICAL INFORMATION

1. General

a. Owner	Montana Department of Natural Resources and Conservation (DNRC)
b. Operator	Cataract Water Users Association
c. Location	Section 23, Township 2 South, Range 3 West (dam location)
d. Latitude	45.64°
Longitude	111.94°
e. County—State	Madison--Montana
f. Watershed Location	Cataract Creek, from Mason Lake; tributary of North Willow Creek
g. Drainage Area	6.1 square miles

2. Principal Elevations (feet above mean sea level)

a. Maximum Dam Crest	6,360.0 feet
b. Normal Full Pool	6,353.0 feet
c. Spillway Crest	6,353.0 feet
d. Outlet Works Invert (from drawings)	6,293.0 feet
e. Toe of Dam	6,280.0 feet

3. Reservoir

a. Length of Maximum Pool (approximate)	0.36 miles
b. Surface Area at (at normal full pool)	45 acres

4. Storage

- | | |
|--|-----------------|
| a. Maximum Storage
(pool at dam crest) | 1,800 acre-feet |
| b. Active Storage
(pool at spillway crest) | 1,478 acre-feet |
| c. Maximum Surcharge
(from spillway crest to dam crest) | 322 acre-feet |

5. Hydrology

- | | |
|------------------------------------|------------------------------|
| a. Probable Maximum
Flood (PMF) | 10,200 cfs (8,450 acre-feet) |
| b. 500-yr Flood | 225 cfs |
| c. 100-year Flood | 160 cfs |

6. Embankment

- | | |
|---------------------|------------|
| a. Type | Earthfill |
| b. Hydraulic Height | 80 feet |
| c. Crest Length | 775 feet |
| d. Crest Width | 20 feet |
| e. Downstream Slope | 1v on 2.0h |
| f. Upstream Slope | 1v on 3.0h |

7. Outlet Works

- | | |
|------------|---|
| a. Size | 30-inch, horseshoe-shaped,
reinforced concrete |
| b. Length | 390 feet |
| c. Control | Two 30-inch diameter gate
valves in series. The
upstream valve is operated
from the bottom of a 5.5 by
5.3 feet square dry tower. The
downstream valve is operated
from the top of the tower. |

- | | |
|------------------------------------|---------|
| d. Capacity
(pool at dam crest) | 160 cfs |
| e. Trashrack | Yes |

8. Spillway

- | | |
|------------------------------------|--|
| a. Location | Right Abutment |
| b. Type | Controlled, unlined, open
channel with a concrete drop
structure |
| c. Width (bottom) | 20 feet |
| d. Length | 720 feet |
| e. Capacity
(pool at dam crest) | 1,250 cfs |

OPERATING PROCEDURES

The Cataract Water Users Association manages Cataract Creek Reservoir to provide an adequate supply of irrigation water to meet contracts with water users without exceeding safe storage and flow levels.

METHOD AND SCHEDULE OF OPERATION

Water stored in the reservoir supplements the flow of North Willow Creek during the irrigation season. The association strives to impound the maximum amount of water below the spillway crest prior to the irrigation season. The reservoir level has reached the spillway crest only twice and generally peaks in late-May or June. Water from the reservoir supplements irrigation flows for a month or more after the reservoir reaches its highest level. Naturally, the actual dates vary depending on each year's climatological and hydrological conditions.

Water from the reservoir is normally discharged via the seepage which exits downstream of the embankment (see Seepage Monitoring section). The timing of these "natural" releases generally suits the needs of the contract holders. Typically, the dam operator only uses the outlet works to allow stored water from Mason Lake to pass through Cataract Dam.

Maximum Winter Storage: The maximum reservoir elevation for winter storage is 6,345.0 feet with 1,139 acre-feet of storage. This winter maximum helps prevent damage to the riprap and embankment from wind-driven waves and ice.

Minimum Winter Storage: The minimum reservoir elevation for winter storage is 6,303.0 feet with 54 acre-feet of storage. This winter minimum helps prevent ice damage to the inlet structure for the outlet works.

SAFE DRAWDOWN

Because the stability of Cataract Creek Dam has not been thoroughly investigated, SWPB recommends that drawdown rates not exceed one foot per day.

LIMITATIONS OF APPURTENANCES

The appurtenances at the dam are the embankment, outlet works, and spillway. The capacity of the outlet works is 160 cfs at the maximum dam crest elevation. The maximum opening is 30 inches for both gates. This is measured from the top of the gate stem to the top of the pedestal. In addition, the spillway will discharge 1,250 cfs when the reservoir water is at the dam crest. A rating table for the spillway is in Appendix A.

DAM OPERATOR

The association has not hired a dam operator. In this manual, the term “dam operator” refers to the court-appointed water commissioner for North Willow Creek.

The association and the dam operator are responsible for the daily operation of the dam and reservoir. While the dam operator performs summer operations of Cataract Creek Dam, all of the members of the association operate the dam during the rest of the year.

The dam operator is generally authorized to operate the reservoir to meet the court's admeasurement of water and the association's goals of supplying water while maintaining safe storage and flow levels. The dam operator's specific responsibilities are to:

1. Distribute water as directed by the court.
2. Operate the mechanical features of the outlet works.
3. Coordinate filling the reservoir and releasing water.
4. Notify the SWPB of unusual occurrences such as vandalism, impending floods, excessive seepage, or problems with the outlet.
5. Notify the association of the need for certain routine maintenance tasks.
6. Monitor weather conditions.
7. Monitor seepage.

Typically, the out-going dam operator and the association train a new dam operator. The dam operator's training focuses on the mechanical operation of the gates, storage level observation, measurement of the rate of water releases, and record keeping. The gates are operated manually with a hand crank or handwheel. The outlet works are intended to be used for controlling the release of irrigation water and not for providing emergency relief.

The dam operator is normally available daily to observe the dam, admeasure irrigation water, and perform operating functions daily during the filling and irrigation season. A landowner adjacent to the dam is on-site regularly tending his stock and reports any problems to the association president who typically visits the dam monthly. While communication among the dam operator, the association, and the SWPB usually takes place by telephone, radio communication may be established during emergencies or unusual occurrences, so that the dam operator or the association can speak directly with county authorities and

communicate indirectly with the SWPB (see *Cataract Creek Dam Emergency Action Plan*).

STORAGE DETERMINATION

Storage in the reservoir and the elevation of the reservoir surface are determined by taking a slope measurement. Measure in feet from the rebar pin, located north of the spillway drop structure below the dam crest near the large rocks, to the water surface. The elevation of the reservoir surface and the storage can then be found using the Slope-Elevation-Storage Table in Appendix A.

WEATHER MONITORING

The association and the dam operator monitor weather conditions through local weather forecasts and the National Weather Service.

If severe flooding is anticipated, the NWS Great Falls Office (**406-453-2081 or 406-453-4561**) should be contacted for information about the storm, such as the estimated storm intensity and duration, runoff duration (above base flow), and total flood volume of the storm in the Cataract Creek drainage.

INTERACTION WITH OTHER DAMS

Except for irrigation diversion dams, Willow Creek Dam is the next dam downstream from Cataract Creek Dam. The safety of Willow Creek Dam is not effected by the normal operation of Cataract Creek Dam.

EMERGENCY

If it appears that Cataract Creek Dam is about to breach, or during emergency operations, the dam operator will initiate the **Cataract Creek Dam Emergency Action Plan.**

During an emergency, the association will notify the operator of Willow Creek Dam (**Barry McLane 406-285-3689**) to observe the inflows into Willow Creek Reservoir and implement the **Willow Creek Dam Emergency Action Plan**, if necessary.

[Faint, illegible text covering the majority of the page, likely bleed-through from the reverse side.]

INSPECTION AND MONITORING

The SWPB conducts annual inspections of the dam. Appendix B includes an example of a SWPB inspection report form. In addition to annual inspections, SWPB personnel will inspect the dam and reservoir during and after heavy runoff, severe rainstorms, and windstorms; during high storage periods; and after an earthquake. The embankment is not monitored by instrumentation.

STRUCTURAL FEATURES INSPECTION

Structural features include the control tower, outlet works, and spillway drop structure (Figure 3). The SWPB will inspect these structures annually as part of its inspection program. Items to be checked or noted include, but are not limited to:

1. Outlet Works
 - a. Any differential settlement or movement resulting in cracking of the conduit
 - b. Erosion of the seals or concrete by cavitation immediately downstream of the gates
 - c. Major seepage of water into the conduit
 - d. Major deterioration of exposed concrete due to freeze/thaw cycles or sulfate reactions
 - e. Operation of both gates through a full cycle
 - f. Free, unobstructed operation of the air vent
 - g. Corrosion of any metal
 - h. Proper lubrication and cleaning of the pedestals
2. Control Tower and Cover
 - a. Any damage or vandalism

3. Spillway
 - a. Deterioration of concrete
 - b. Separation or movement of joints
 - c. Cracking or displacement of the concrete floor or sidewalls
 - d. Blockage of the approach or exit channel
4. Embankment
 - a. Erosion gullies in the dam or dam abutments
 - b. Damage from burrowing animals or vegetation
 - c. Displacement or loss of rip-rap protection
 - d. Displacement of fill, sink hole's, slumps etc.
 - e. Any seepage

RIPRAP INSPECTION

The riprap along the faces of the dam should be at least 30 inches thick (the original placement depth). Immediately after the occurrence of high water, the riprap will be inspected and additional riprap added if needed.

SEEPAGE MONITORING

No seepage has been observed along the immediate downstream toe of the dam. However, seepage does occur at different locations in the wide, relatively flat reach of Cataract Creek immediately below the dam. As you move downstream of the dam, net seepage increases substantially, and eventually shows as streamflow. Based on measurements and observations made in 1997, the location of where the seepage exits downstream of the dam is directly related to the height of the reservoir pool. The higher the reservoir level, the closer to the downstream dam embankment the seepage exits. The closest the seepage has been observed to the downstream dam toe is about 65 feet below the

outlet structure. Appendix C contains a table of the data collected in 1997.

Based on the 1997 measurements, the flow in Cataract Creek below the dam is seepage from the dam, although its flow path is not well understood. It is likely a majority of the seepage losses originates from within the reservoir itself. A portion of the borrow materials for construction of the dam were obtained from the reservoir area. It is possible that seepage paths were uncovered during borrow material excavation. Active sinkholes around the reservoir rim, discovered during the 1997 and 1998 annual inspections, support this conclusion.

The seepage flow (quantity and turbidity) is monitored at a Parshall Flume approximately ½ mile downstream from the dam. The flow is always clear, and no unexplained increases in flow have occurred.

Two shallow hand driven monitoring wells were installed in the fall of 1996 below the toe of the dam. One is located to the left of the outlet, while the other is located to the left and approximately 100 feet downstream of the outlet. These monitoring wells extend only 5 to 10 feet deep.

A concrete toe drain extends along the toe of the dam downstream of the cutoff trench. The drain exits along the downstream toe in the right groin approximately 10 feet above the outlet wing walls. In 1997, the drain flow varied from 0 to 67 gpm, depending on the height of the reservoir pool. The drain is measured by a bucket and stopwatch.

The seepage flow, drain flow, and monitoring wells will be recorded by the SWPB during annual inspections. The areas of

seepage will be observed and monitored by the dam operator during regular visits.

MAINTENANCE

The association is responsible for routine maintenance of the project. In addition the SWPB may identify items that need maintenance or repair during the annual inspection.

ROUTINE MAINTENANCE

To protect the dam and keep it in good working order, the dam operator during regular visits to the dam will watch for and identify any potential maintenance requirements. As soon as a need is identified, the dam operator and the association needs to schedule and perform the routine maintenance.

Items that may occasionally need attention include, but are not limited to:

1. *Lubrication and cleaning of gate-operating mechanisms.*
2. *Debris or silt restricting the spillway inlet or outlet works.* Accumulated debris that could effect the operation of these appurtenances will be removed at once, with all debris removed at least annually.
3. *Erosion gullies on embankment.* Development of erosion gullies will be checked immediately. Gullies will be filled, compacted, and seeded. Particular attention will be paid to the abutment contact areas and the downstream face where four-wheel-drive or motorcycle tracks may become a problem.
4. *Rodent damage.* The rodents will be removed or destroyed, and any burrows holes should be filled immediately.
5. *Upstream slope riprap.* Reservoir riprap normally will be observed annually, but may occasionally need repairs because of high water or wave action.
6. *Vegetative cover on downstream slope.* Good vegetative cover will be maintained, but large brush and trees will be removed from the downstream slope and the spillway

channel.

7. *Noxious weeds.* Weeds on and around the dam should be sprayed on at least an annual basis.
8. *Clean spillway and outlet structure wall tops.* Spillway and outlet structure wall tops should be clear of any dirt, rocks, grass, brush, and any overhanging vegetation or trees.
9. *Repair joints and seal cracks in the spillway*

ANNUAL MAINTENANCE

The SWPB conducts annual inspections of Cataract Creek Dam and Reservoir. During these inspections, any items requiring maintenance will be identified and recorded. Items that need annual maintenance include the spillway, outlet works, gates, riprap, roads, and gate house. Other routine items needing immediate attention, such as the need to remove trees and brush, will also be noted.

After the inspection, the SWPB sends the association a Dam Safety Inspection Report and a Maintenance Schedule Report. The reports identify items that need maintenance and provide a schedule of when the maintenance tasks need to be completed. The association is responsible for performing the maintenance items within the times specified.

The dam operator or association members may perform the maintenance tasks. However, major repairs will likely be to handled by a contractor. The SWPB may assist in contracting for repairs and may supervise the repair work.

RECORD KEEPING

The SWPB maintains records, including photographs, of all inspections and maintenance requirements. These records also include seepage monitoring observations. Anyone who wants to

review these records may do so in the SWPB's office at the Department of Natural Resources and Conservation in Helena.

The dam operator will keep records of the reservoir elevation, seepage observations or measurements, and any unusual conditions. These records may be reviewed at the dam operator's house.

REFERENCES

CH2M Hill. April 1980. *Phase 1 Inspection Report, National Dam Safety Program, Cataract Creek Dam, Pony, Montana, Madison County, MT-5*. Prepared for the State of Montana (DNRC) under the U.S. Army Corps of Engineers National Dam Safety Program.

Omang, R.J. July 1992. *Analysis of the Magnitude and Frequency of Floods and the Peak-Flow Gaging Network in Montana*. Water-Resources Investigations Report 92-4048. U.S. Geological Survey.

Reich, George; President, Cataract Creek Water Users Association. December 1993 and March 1994.

Personal telephone communication with Jim Beck, Regional Office Engineer, MT Water Resources Division, DNRC, Helena.

APPENDICES

APPENDIX A
RATING CURVES AND TABLES

**TABLE 1. SLOPE- ELEVATION-STORAGE TABLE
CATARACT CREEK RESERVOIR**

Pins installed and elevations established in 1996.

Storage values based on 1959 original hand surveys of the reservoir.

The 0+00 pin is located north of the spillway drop structure below the dam crest near the large rocks.

DISTANCE feet	ELEVATION feet	STORAGE acre-feet		DISTANCE feet	ELEVATION feet	STORAGE acre-feet
Top Pin #1	6351.54	1387		36	6343.20	1070
0	6351.09	1376		37	6343.05	1064
1	6350.76	1367		38	6342.91	1058
2	6350.44	1359		39	6342.76	1053
3	6350.11	1350		40	6342.61	1047
4	6349.79	1338		41	6342.49	1043
5	6349.46	1324		42	6342.37	1038
6	6349.32	1319		43	6342.26	1034
7	6349.08	1308		44	6342.14	1030
8	6348.85	1299		45	6342.02	1025
9	6348.61	1289		46	6341.94	1022
10	6348.37	1279		47	6341.85	1018
11	6348.16	1270		48	6341.77	1015
12	6347.95	1262		49	6341.68	1011
13	6347.75	1254		50	6341.60	1008
14	6347.54	1245		51	6341.56	1006
15	6347.33	1236		52	6341.51	1004
16	6347.15	1228		53	6341.47	1003
17	6346.98	1221		54	6341.42	1002
18	6346.80	1214		55	6341.38	1000
19	6346.63	1207		56	6341.34	999
20	6346.45	1199		57	6341.30	997
21	6346.22	1190		58	6341.25	995
22	6345.99	1181		59	6341.21	993
23	6345.77	1172		60	6341.17	992
24	6345.54	1162		61	6341.01	985
25	6345.31	1152		62	6340.86	979
26	6345.09	1143		63	6340.70	974
27	6344.87	1134		64	6340.55	968
28	6344.66	1126		Top Pin #2	6340.86	979
29	6344.44	1118		65	6340.39	962
30	6344.22	1110		66	6340.00	947
31	6344.05	1103		67	6339.60	933
32	6343.87	1096		68	6339.21	919
33	6343.70	1089		69	6338.81	905
34	6343.52	1083		70	6338.42	892
35	6343.34	1076				
DISTANCE	ELEVATION	STORAGE		DISTANCE	ELEVATION	STORAGE

TABLE 1. SLOPE- ELEVATION-STORAGE TABLE (continued)
CATARACT CREEK RESERVOIR

DISTANCE feet	ELEVATION feet	STORAGE acre-feet		DISTANCE feet	ELEVATION feet	STORAGE acre-feet
71	6338.13	882				
72	6337.84	872				
73	6337.55	862				
74	6337.26	851				
75	6336.97	841				
76	6336.64	830				
77	6336.31	818				
78	6335.97	806				
79	6335.64	795				
80	6335.31	783				
81	6335.16	779				
82	6335.01	772				
83	6334.86	768				
84	6334.71	762				
85	6334.56	758				
86	6334.40	753				
87	6334.25	748				
88	6334.10	743				
89	6333.95	739				
90	6333.80	734				
91	6333.41	721				
92	6333.02	709				
93	6332.64	696				
94	6332.25	684				
95	6331.86	672				
96	6331.43	658				
97	6330.99	644				
98	6330.56	630				
99	6330.12	616				
100	6329.69	603				
101	6329.26	591				
102	6328.82	578				
103	6328.39	566				
104	6327.95	553				
105	6327.52	540				
106	6327.08	526				
107	6326.65	514				
108	6326.22	502				
109	6325.78	488				
110	6325.35	477				
111	6324.91	463				
112	6324.48	452				
113	6324.05	442				
114	6323.61	430				
115	6323.18	419				
115.8	6322.83	410				

**TABLE 2. TOTAL STORAGE CAPACITY IN ACRE-FEET
CATARACT CREEK RESERVOIR**

Elevation	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
6280	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6281	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
6282	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
6283	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
6284	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6285	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
6286	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5
6287	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7
6288	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8
6289	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	1.0	1.0
6290	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
6291	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
6292	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
6293	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9
6294	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9
6295	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5
6296	11	11	12	12	13	13	13	14	14	15
6297	15	16	16	17	17	18	18	19	19	20
6298	20	20	21	21	22	22	22	23	23	24
6299	24	25	25	26	26	27	27	28	28	29
6300	29	30	31	31	32	33	34	35	35	36
6301	37	38	39	39	40	41	42	43	43	44
6302	45	46	47	48	49	50	50	51	52	53
6303	54	55	56	56	57	58	59	60	60	61
6304	62	63	64	64	65	66	67	68	68	69
6305	70	71	73	74	75	77	78	79	80	82
6306	83	84	86	87	89	90	91	93	94	96
6307	97	98	100	101	102	104	105	106	107	109
6308	110	111	113	114	116	117	118	120	121	123
6309	124	125	127	128	129	131	132	133	134	136
6310	137	139	141	142	144	146	148	150	151	153
6311	155	157	159	160	162	164	166	168	169	171
6312	173	175	176	178	180	182	183	185	187	188
6313	190	192	194	195	197	199	201	203	204	206
6314	208	210	212	213	215	217	219	221	222	224
6315	226	228	230	233	235	237	239	241	244	246
6316	248	250	252	255	257	259	261	263	266	268
6317	270	272	274	277	279	281	283	285	288	290
6318	292	294	296	299	301	303	305	307	310	312
6319	314	316	318	321	323	325	327	329	332	334
6320	336	339	341	344	346	349	352	354	357	359
6321	362	365	367	370	372	375	378	380	383	385
6322	388	391	393	396	398	401	404	406	409	411
6323	414	417	419	422	424	427	430	432	435	437
6324	440	443	445	448	450	453	456	458	461	463
6325	466	469	472	475	478	481	483	486	489	492

TABLE 2. TOTAL STORAGE CAPACITY IN ACRE-FEET (continued)
CATARACT CREEK RESERVOIR

Elevation	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
6326	495	498	501	504	507	510	512	515	518	521
6327	524	527	530	533	536	539	542	545	548	551
6328	554	557	560	563	566	569	571	574	577	580
6329	583	586	589	592	595	598	600	603	606	609
6330	612	615	618	622	625	628	631	634	638	641
6331	644	647	650	654	657	660	663	666	670	673
6332	676	679	682	686	689	692	695	698	702	705
6333	708	711	714	718	721	724	727	730	734	737
6334	740	743	746	750	753	756	759	762	766	769
6335	772	776	779	783	786	790	793	797	800	804
6336	807	811	814	818	821	825	828	832	835	839
6337	842	846	849	853	856	860	863	867	870	874
6338	877	881	884	888	891	895	898	902	905	909
6339	912	916	919	923	926	930	933	937	940	944
6340	947	951	955	958	962	966	970	974	977	981
6341	985	989	993	997	1001	1005	1008	1012	1016	1020
6342	1024	1028	1032	1035	1039	1043	1047	1051	1054	1058
6343	1062	1066	1070	1074	1078	1082	1085	1089	1093	1097
6344	1101	1105	1109	1112	1116	1120	1124	1128	1131	1135
6345	1139	1143	1147	1152	1156	1160	1164	1168	1173	1177
6346	1181	1185	1189	1193	1197	1202	1206	1210	1214	1218
6347	1222	1226	1230	1235	1239	1243	1247	1251	1256	1260
6348	1264	1268	1272	1276	1280	1285	1289	1293	1297	1301
6349	1305	1309	1313	1318	1322	1326	1330	1334	1339	1343
6350	1347	1350	1352	1355	1357	1360	1363	1365	1368	1370
6351	1373	1376	1378	1381	1383	1386	1389	1391	1394	1396
6352	1399	1402	1404	1407	1410	1413	1415	1418	1421	1423
6353	1426	1429	1431	1434	1436	1439	1442	1444	1447	1449
6354	1452	1455	1457	1460	1462	1465	1468	1470	1473	1475
6355	1478	1484	1491	1497	1504	1510	1516	1523	1529	1536
6356	1542	1549	1555	1562	1568	1575	1581	1588	1594	1601
6357	1607	1613	1620	1626	1633	1639	1645	1652	1658	1665
6358	1671	1678	1684	1691	1697	1704	1710	1717	1723	1730
6359	1736	1742	1749	1755	1762	1768	1774	1781	1787	1794
6360	1800									

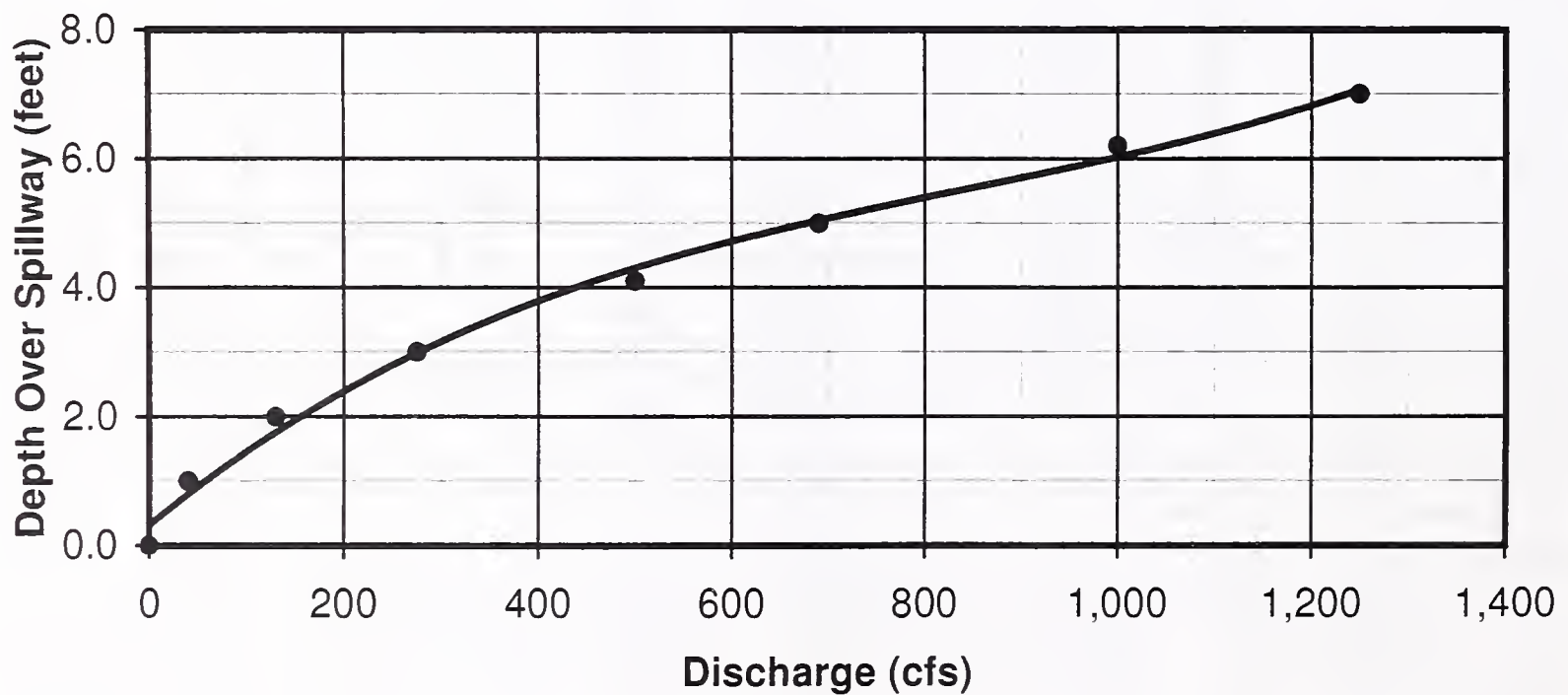
NOTE: Storage table based on 1959 original hand surveys of the reservoir.
 Spillway crest Elevation 6,353 feet Storage 1,478 acre-feet
 Dam Crest Elevation 6,360 feet Storage 1,800 acre-feet

TABLE 3. SPILLWAY DISCHARGE

CATARACT CREEK RESERVOIR

Depth Over Crest (feet)	Elevation (feet)	Discharge (cfs)
0.0	6,353.0	0
1.0	6,354.0	40
2.0	6,355.0	130
3.0	6,356.0	275
4.1	6,357.1	500
5.0	6,358.0	690
6.2	6,359.2	1,000
7.0	6,360.0	1,250

CATARACT DAM SPILLWAY RATING CURVE



Note: Data from the Corps of Engineers Phase 1 Inspection Report (1980).

APPENDIX B

INSPECTION REPORT FORM

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
DAM SAFETY INSPECTION REPORT

NAME OF DAM _____
DATE INSPECTED _____

INVENTORY NO. _____
HAZARD CATEGORY _____
TYPE OF DAM _____
YEAR BUILT _____

OWNER _____
OPERATOR _____
STREAM _____
DRAINAGE AREA _____

Reservoir Storage Status

	Water Surface Elevation (feet)	Storage (acre-feet)
At time of inspection	_____	_____
At spillway crest	_____	_____
At min. dam crest elevation	_____	_____

ITEM	YES	NO	REMARKS
------	-----	----	---------

1. EMBANKMENT

A. Crest -- Height= Length= Width=

(1) Any visual settlements?			
(2) Any misalignments?			
(3) Any cracking?			
(4) Any traffic damage?			
(5) Other?			

ITEM	YES	NO	REMARKS
------	-----	----	---------

1. EMBANKMENT (continued)

B. Upstream Face -- Slope=

(1) Any erosion?			
(2) Any longitudinal cracks?			
(3) Any transverse cracks?			
(4) Is riprap protection adequate?			
(5) Any stone deterioration?			
(6) Any visual settlement, slumps, sloughing, depressions or bulges?			
(7) Adequate grass cover?			
(8) Debris on the dam face?			
(9) Other?			

C. Downstream Face--Slope=

(1) Any erosion?			
(2) Any longitudinal cracks?			
(3) Any transverse cracks?			
(4) Any visual settlement, slumps, sloughing, depressions or bulges?			
(5) Is the toe drain dry?			
(6) Are the relief wells flowing?			
(7) Any boils at the toe?			
(8) Any seepage areas?			
(9) Any traffic or animal damage?			
(10) Any burrowing animals?			
(11) Adequate grass cover?			
(12) Other?			

D. Amount and Type of Vegetation on the Dam

--

ITEM	YES	NO	REMARKS
------	-----	----	---------

2. ABUTMENT CONTACTS

A) Any erosion?			
B) Any visual differential movement?			
C) Any cracks?			
D) Any seepage present?			
E) Other?			

3. OUTLET WORKS

A. Intake Structure -- Size=

(1) Any settlement?			
(2) Any tilting?			
(3) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(4) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(5) Metal appurtenances:			
a. Any corrosion present?			
b. Any breakage present?			
(6) Trash rack?			
a. Condition?			
b. Anchor system secure?			
(7) Other?			

ITEM	YES	NO	REMARKS
------	-----	----	---------

3. OUTLET WORKS (continued)

B. Conduit -- Type =

Size =

(1) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(2) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(3) Is the conduit metal?			
a. Any corrosion present?			
b. Protective coatings adequate?			
(4) Is the conduit misaligned?			
(5) Any calcium deposits?			
(6) Other?			

C. Gates and Tower

(1) Gates:			
a. Size: Operating:		Emergency:	
b. Type: Operating:		Emergency:	
(2) Controls operational?			
(3) Controls lubricated?			
(4) Operational problems?			
(5) Leakage around gates?			
(6) Condition of gate seals?			
(7) Any cavitation damage? If so, describe?			
(8) Describe air vent-size and condition.			

ITEM	YES	NO	REMARKS
------	-----	----	---------

3. OUTLET WORKS (continued)

C. Gates and Tower (continued)

(9) Is there a jet pump?			
a. Is it operational?			
b. Leakage?			
(10) Is the tower dry? ____ wet? ____			
(11) Any seepage in the tower?			
(12) Condition of the tower?			
(13) Any safety problems?			
(14) Ladder in good condition?			
(15) Condition of the gatehouse?			
(16) Emergency plan completed for the dam?			
a. Posted in the gatehouse?			
(17) Other?			

D. Stilling Basin

(1) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(2) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(3) Do energy dissipaters show:			
a. Signs of deterioration?			
b. Are they covered with debris?			
(4) Other?			

ITEM	YES	NO	REMARKS
------	-----	----	---------

3. OUTLET WORKS (continued)

E. Downstream Channel

(1) Is the channel:			
a. Eroding or backcutting?			
b. Sloughing?			
c. Obstructed?			
(2) Is released water:			
a. Undercutting the outlet?			
b. Eroding the embankment?			
(3) Other?			

4. SPILLWAY

A. Description

(1) Location?			
(2) Type of Spillway?			
(3) Size of Spillway?			
(4) Spillway lining?			
(5) Is there a weir?			
(6) Is the spillway in good condition?			
(7) Any drains?			
a. Describe the condition of drains.			

B. Does spillway show:

(1) Any cracking concrete?			
(2) Any spalling concrete?			
(3) Any exposed reinforcement in the concrete?			
(4) Any erosion?			

ITEM	YES	NO	REMARKS
------	-----	----	---------

4. SPILLWAY (continued)

4. B. Does spillway show: (continued)

(5) Any slope sloughing?			
(6) Any obstructions?			
(7) Displacement or offset joints?			
(8) Loss of joint material?			
(9) Leakage at the joints?			
(10) Other?			

C. Do the energy dissipaters show:

(1) Signs of deterioration?			
(2) Any cracking?			
(3) Any spalling?			
(4) Any exposed reinforcement?			
(5) Are they covered with debris?			
(6) Other?			

D. Has release water:

(1) Eroded the embankment?			
(2) Undercut the outlet?			
(3) Eroded the downstream channel?			
(4) Other?			

E. Emergency Spillway

(1) Is there an emergency spillway?			(If YES, describe)

ITEM	YES	NO	REMARKS
------	-----	----	---------

5. RESERVOIR CONTROL

A) Recent upstream development?			
B) Recent downstream development?			
C) Slides in reservoir area?			
D) Change in reservoir operation?			
E) Large impoundment upstream?			
F) Any debris in the reservoir?			
G) Other?			

6. INSTRUMENTATION

A) List type(s) of instrumentation:			
B) In good condition?			
C) Read periodically?			
D) Is data available?			
E) Include all data gathered since last report.			

7. DOWNSTREAM CONDITION

A. Downstream Land Use.

--

This dam was inspected by:

Additional comments and recommendations.

APPENDIX C
SEEPAGE DATA

CATARACT RESERVOIR SEEPAGE DATA

Date	Inflow cfs	Seepage Outflow cfs	Drain Flow gpm	Drain Turbidity NTU	Piez #1 ft	Piez #2 ft	Appearance Of Seepage feet from outlet	Reservoir Slope feet	Reservoir Capacity acre feet	Reservoir Elevation feet
3/28/97	2.17	0.17	0.0	-----	Not Measured	Not Measured	Snow - none visible		235.0	6315.50
4/17/97	2.46	0.66	0.0	-----	Not Measured	Not Measured	1000 - 1100		330.0	6322.70
5/5/97	3.90	1.20	0.0	-----	Not Measured	Not Measured	900 - 1000		410.0	6322.83
5/16/97	7.30	1.86	wet	-----	Dry	No Water	700	111.0	465.0	6324.91
5/22/97	9.02	2.95	dry	-----	Dry	No Water	600	106.5	521.5	6326.90
6/3/97	16.46	5.93	5.0	-----	Dry	4.00	150	93.5	692.0	6332.50
6/10/97	18.90	6.68	14.0	-----	Dry	3.04	97	85.0	767.0	6334.56
6/17/97	14.43	8.10	45.1	1.84	8.70	2.35	76	68.4	913.4	6339.05
6/25/97	16.30	9.23	57.0	-----	8.80	2.20	At Dam (72?)	32.0	1,096.0	6343.87
7/1/97	22.10	8.91	56.0	-----	8.60	2.27	At Dam (69?)	23.5	1,165.0	6345.66
7/9/97	11.65	9.51	64.9	2.34	8.12	2.12	66	20.3	1,196.0	6346.38
7/16/97	10.24	10.32	66.7	2.28	7.89	2.18	66	21.7	1,184.1	6346.30
7/22/97	9.77	9.31	47.0	-----	8.00	2.25	At Dam (66)	25.0	1,152.0	6345.31
7/28/97	8.95	9.71	53.0	-----	7.95	2.32	At Dam (66)	29.5	1,144.0	6344.33
8/4/97	7.88	10.06	-----	-----	8.21	2.33	At Dam (66)	36.4	1,067.0	6343.13
8/11/97	6.74	9.19	41.4	-----	8.50	2.39	At Dam (66)	58.0	995.0	6341.25
8/18/97	7.56	9.05	37.5	-----	9.05	2.35	At Dam (66)	67.5	926.0	6339.40
8/28/97	6.14	9.10	26.6	-----	dry	2.66	70	76.0	830.0	6336.64
9/8/97	5.41	8.01	10.2	-----	dry	2.88	98	87.0	748.0	6334.25
9/19/97	4.96	7.01	2.6	-----	dry	3.25	115	96.0	658.0	6331.00
10/1/97	4.04	5.12	dry	-----	dry	4.27	133	103.0	566.0	6328.39
6/2/98	8.5 (est)	5.7 (est)	0.9	-----	dry	4.93	200	99.5	610.0	6329.90
9/23/98	-----	-----	dry	-----	dry	6.86	Did not measure distance	109.0	488.0	6325.78
7/19/99	-----	-----	7.5	-----	dry	2	101	88.0	743.0	6334.10

APPENDIX D

O&M MANUAL DISTRUBUTION LIST

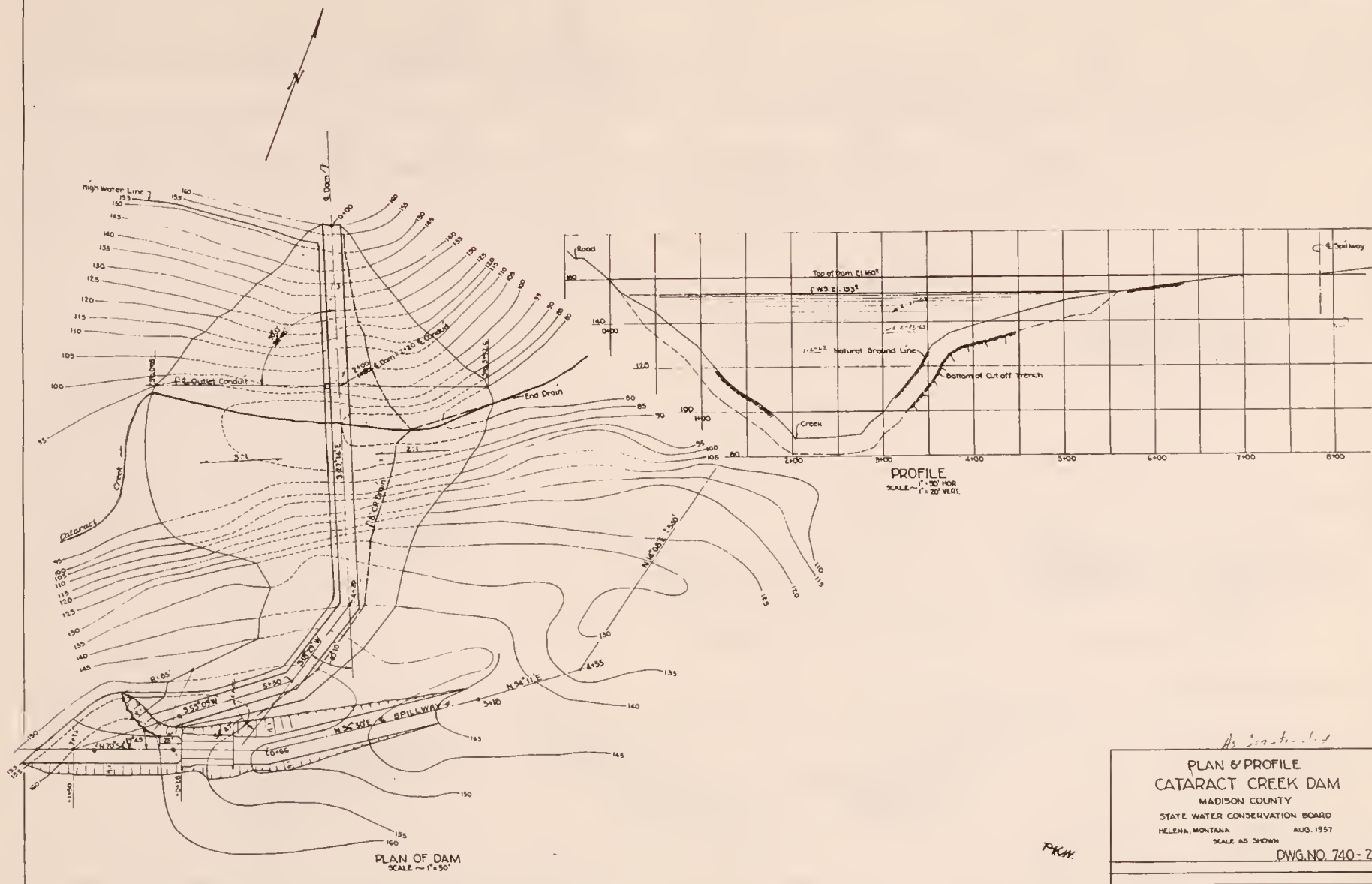
CATARACT DAM
O&M DISTRIBUTION LIST

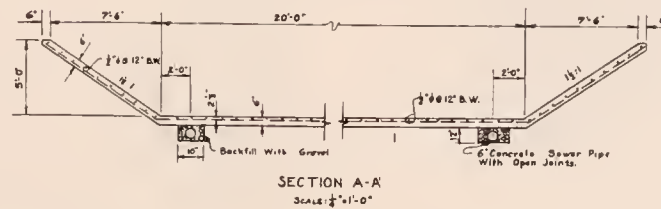
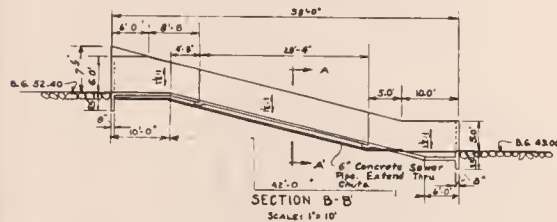
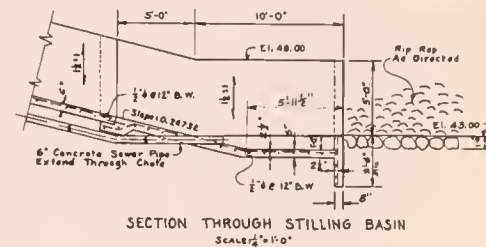
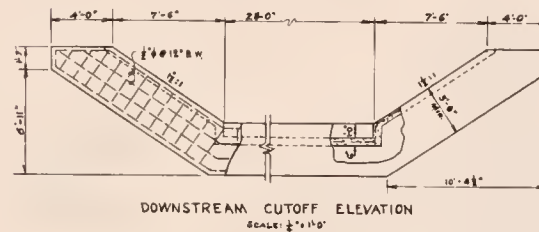
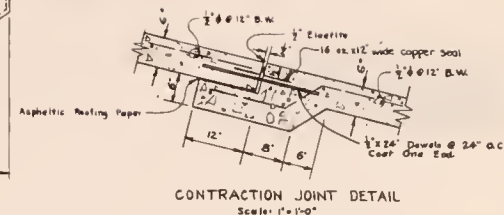
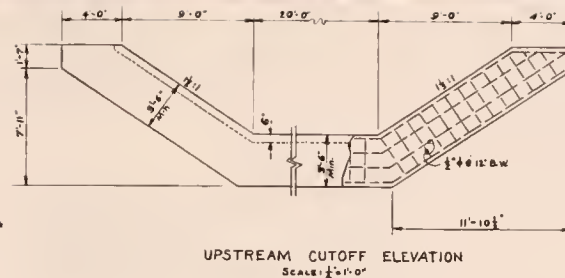
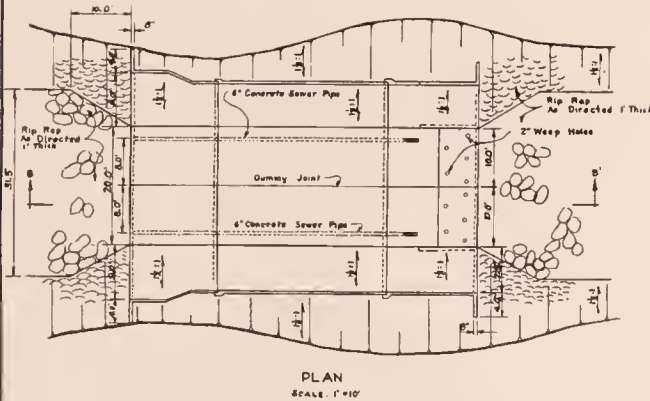
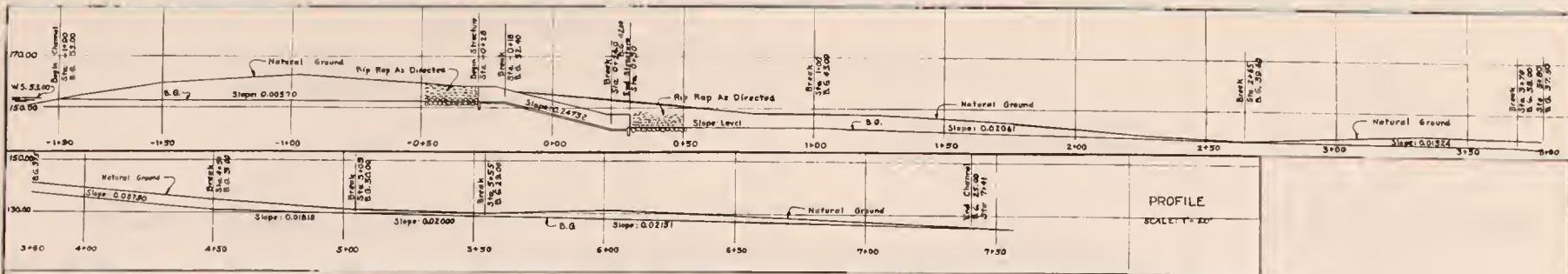
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Glen McDonald	
Greg Ames	
Art Taylor (2)	
Bob Arrington	
Bob Clark	
Dolores Eustice	
2. DNRC Information Services Section	1
3. Regional Office	2
Scott Compton (Bozeman)	
Jim Beck (Helena)	
4. Dam Safety	1
5. Water Users	
George Reich -- President /Dam Operator	4
Bob Rice -- Vice president	
William Jackson -- Secretary	
Jim Sitz -- Director	
6. Willow Creek Water Users	1
LeRoy Miller -- President	
7. State Library -- Attn: Roberta Gebhardt	4
8. Extra	2
=====	
TOTAL	22

APPENDIX E

PROJECT DRAWINGS

(NOTE: These reduced project drawings are design drawings and not "As Builts". These drawing should be used for reference only. The SWPB has the full size project drawings.)





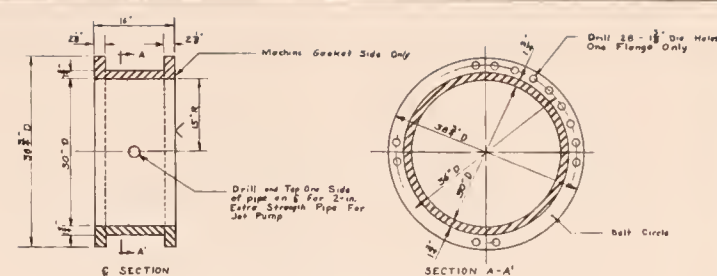
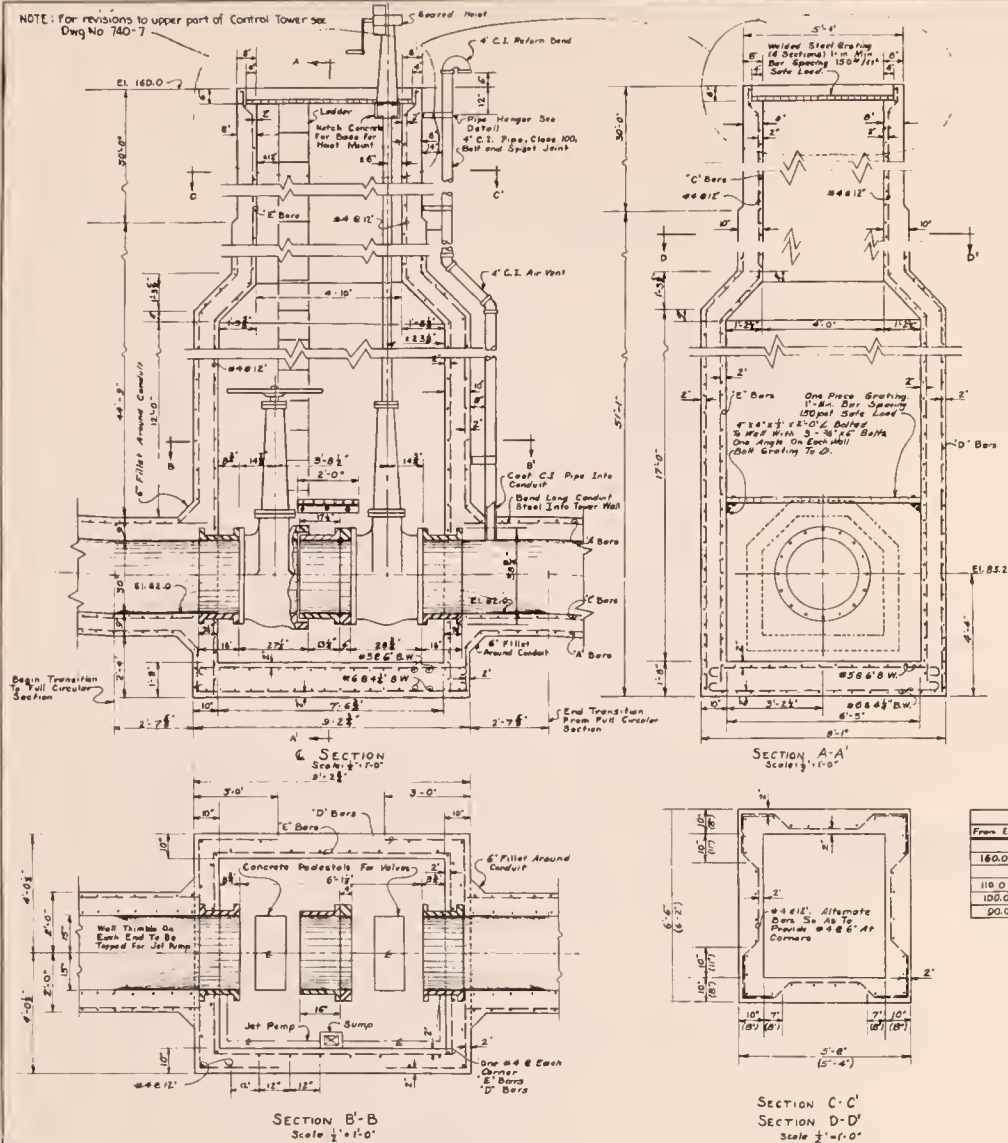
GENERAL NOTES
Reinforcing Steel to have minimum concrete cover of 2".
Chamfer all exposed concrete edges 1".

SPILLWAY PROFILE AND DETAILS
CATARACT CREEK DAM
MADISON COUNTY
STATE WATER CONSERVATION BOARD
HELLENA, MONTANA MARCH 1956

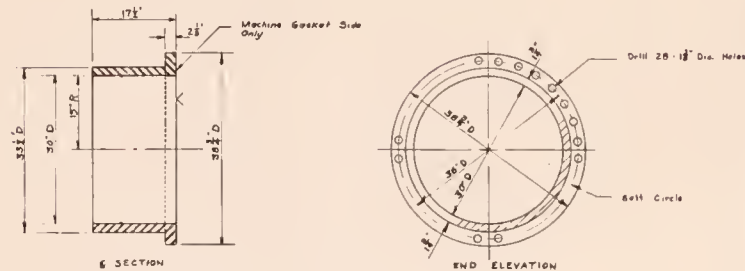
SCALE: AS SHOWN
DWG. No. 740-3

TRV: J.C. 16 Aug 57
DWG: J.C. Feb 55

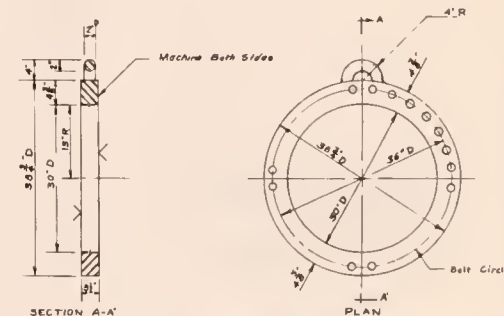
NOTE: For revisions to upper part of Control Tower see
Dwg No 740-7



SPECIAL FLANGED PIPE - 2 REDD. C.I.
Scale 1\"/>



SPIGOT END FLANGED PIPE - 1 REDD. C.I.
Scale 1\"/>



SPECIAL PLAIN FLANGE C.I.
Scale 1\"/>

TOWER STEEL SCHEDULE			
From Elev.	To Elev.	'O' Bars	'E' Bars
160.0	110.0	As Shown in Section D-D & E-C	
110.0	100.0	#6 @ 6"	#5 @ 8"
100.0	90.0	#6 @ 5"	#5 @ 7"
90.0	80.0	#6 @ 4"	#6 @ 3"

NOTES:

Values shall conform to specifications for double gate valves as note A-1 of the special provisions of this contract. The above detailed figures and fittings shall conform to the specifications in A-1 of this contract. Standard specifications, except as above noted.

REVISED STRUCTURAL, VALVE, AND FITTING DETAILS FOR
CONTROL TOWER

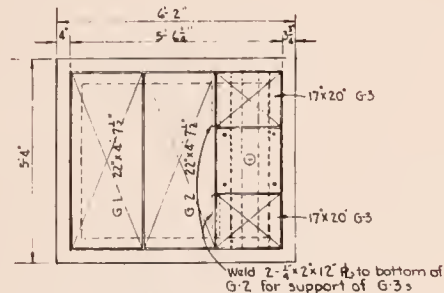
CATARCAT CREEK DAM
MADISON COUNTY

STATE WATER CONSERVATION BOARD
HELENA, MONTANA 5 JUNE 1958

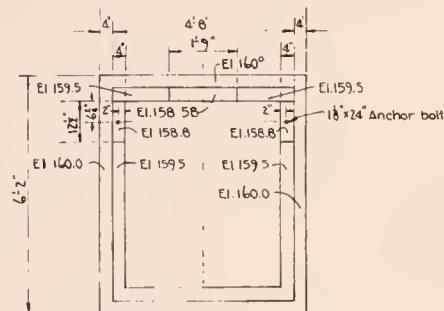
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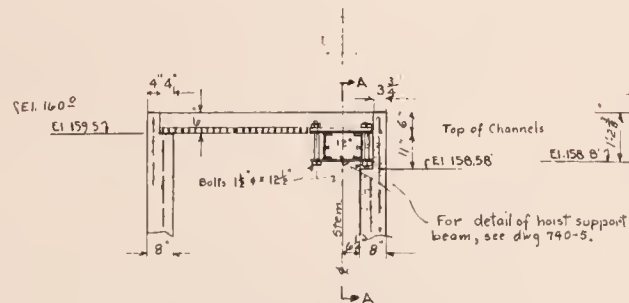
Drawn By: J.C. 5 Jun 58



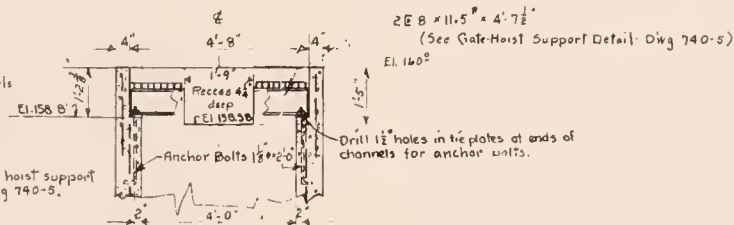
PLAN OF CONTROL TOWER
SHOWING GRILLAGE DETAILS



PLAN OF CONTROL TOWER
SHOWING RECESSES FOR HOIST SUPPORT



PARTIAL SECTION OF CONTROL TOWER
SHOWING GRILLAGE & HOIST SUPPORT



SECTION A-A

PAUL M.
WILLIAMS
10/1/56

REVISIONS TO CONTROL TOWER CATARACT CREEK DAM

MADISON COUNTY
STATE WATER CONSERVATION BOARD
HELENA, MONTANA OCT. 1956

SCALE ~ 1/2" = 1'-0"

DWG. NO. 740-7

